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REVIEW ARTICLE

Glide path establishing instruments – An overview

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Abstract

Background: Mechanical preparation of a root canal system plays a key role in providing a successful and a more predictable endodontic treatment outcome. The intricate anatomy of root canals often poses a challenge for clinicians in aiding this objective. The preparation of a glide path provides a basis for effective cleaning and shaping, enabling all the subsequent instruments to move smoothly through the canal till the apical constriction, unhindered. A reproducible glide path enhances clinicians' efficacy in understanding root canal anatomy, thus reducing the likelihood of procedural errors. **Aim**: This review article illustrates the importance of glide path preparation and also explains the numerous glide path instruments available over the years. **Conclusion**: Glide path is the key to radicular rotary safety. It is a pre-requisite to achieve the rationale of endodontics. **Clinical Significance**: Preparing a glide path increases the life span of rotary instruments, reduce the risk of procedural errors, providing the clinician a more detailed route map of the canal anatomy.

Keywords: Glide path, NiTi, reciprocating, rotary, stainless steel K-file

Introduction

The objectives and techniques established by Schilder, for a predictable and efficient treatment of root canal system, continue to be profoundly relevant even after all the revolutionary advances dated so far.[1] Due to anatomical variations and complexity of root canal morphology, root canal preparation continues to be a challenging task for endodontists. Clinicians most often experience procedural complications during canal scouting and pre-flaring, the initial stages of canal instrumentation.[2,3] Excellent instrumentation is facilitated by the first scouting with K-files, then creating a hand-generated "glide path," refining this hand glide path with rotary files and finishing the preparation with the final hand or rotating instrumentation.[4] Preparing a glide path thus allows better canal curvature management, maintaining the original canal morphology, and eliminating procedural errors associated with canal cleaning and shaping.

Glide path

In aeronautics, glide path is the line of descent to the land of aircraft, particularly as indicated by the ground radar. Its purpose is to establish a tightly controlled horizontal and vertical "corridor" at the end of the runway which will take the incoming aircraft to the correct location.[5] In 2010, John West defined endodontic glide path as "a smooth, though possibly narrow, tunnel, or passage from the coronal orifice of the canal to the radiographic terminus or electronically determined portal of exit."[6] He advised, the minimum requirement to be a "super loose No. 10" endodontic K-file. The glide path must be discovered if already present in the canal anatomy or prepared if it is not present. Glide path can be short or long, narrow, or wide, essentially straight or curved.[6] It is a refinement of the original canal anatomy, allowing the shaping instruments to advance more safely.

Significance of Canal Scouting and Preflaring

Initial canal negotiation and glide path preparation help in providing valuable knowledge on the morphology of canals.[7] Blum *et al*. suggested the initial construction of a glide path with smaller stainless steel hand files to ensure that adequate space is available for the rotary instruments to follow through the root canal.[8] Broadly, NiTi rotary files are manufactured with non-cutting tips and these instruments are not intended for initial root canal negotiation due to their extreme flexibility and non-aggressive tip.[9] Gmans *et al.* claimed, a hand instrument should be previously placed before the use of any rotary instruments.[10] Berutti *et al.* reasoned, usage of hand-operated preflaring and glide path preparation before any rotary NiTi instruments aides in the improved longevity of NiTi instruments along with enhanced torsional resistance.[11] Patiño *et al.* reported a marked decrease in the breakage of NiTi instruments when a glide path was created beforehand.[12] However, establishing this glide path by stiffer stainless hand files combined with their aggressive tip presents a greater risk of causing variations in the geometry of the canal contributing to the formation of ledges, zipping, apical transportation, and even canal perforations.[13] These procedural errors tend to hamper the anatomic apex of the tooth and change the original curvature of the canal, especially in narrow, curved, and calcified canals. Although it is acknowledged that establishing a reproducible glide path is crucial, suitable instrumentation is essential to accomplish this objective. Over the past 5 years, several manufacturers have introduced small taper (0.01–0.02) rotary NiTi instruments in small sizes (10–20) for the negotiation and creation of glide paths instead of a glide path prepared by hand instrumentation.

Glide Path Preparation Instruments [Table 1]

Diverse range of glide path preparation instruments are available in different motions and techniques, which can be categorized under manual, rotary and reciprocating glide path instruments. [Table 1].

Glide Path Preparation Methods

Manual glide path preparation techniques

Manual glide path preparation can be performed by hand using stainless steel K-files or in combination with a reciprocating handpiece.

Hand stainless steel K-file

Instrument available for manual glide path preparation is – sizes ISO 10 (purple) and 15 (white) stainless steel K-files.

In 2006, West recommended the use of an initial watch-winding motion by the K-file, to remove restricted dentin in very narrow canals, followed by a vertical up and down movement with an amplitude of 1 mm and slowly increasing the amplitude as the dentinal layer shaves off, guiding the file to progress toward the apex. Berutti *et al.* recommended a glide path preparation such that, the diameter created by glide path should have a size bigger than the initial shaping rotary instrument tip size.[11] West[14] promotes the balance forced motion by Roane *et al.*,[15,16] particularly when the canal demands a greater size glide path than ISO 10 K-file. This technique described by Roane *et al.*, advocates turning the file in a CW direction to engage in dentine, followed by a CCW motion while maintaining apical pressure to avoid unscrewing of the file in the canal. This motion is repeated for the apical progression of the file. In 2010, West[17] further advised that the minimum glide path requirement be a "super loose" size 10 K-file. If a size 15 or 20 K-file can be moved 3–5 mm from the working length and gently pushed back to the original length unaccompanied by any rotational movement, establishes a reproducible glide path [Table 2].[18]

Hand files in reciprocating handpiece

In 2008, Kinsey and Mounce described a technique using a reciprocating handpiece attached to small size K-file for glide

Table 1: Glide path instruments

Manual glide path preparation instruments	Rotary glide path preparation instruments	Reciprocating glide path preparation instruments
Hand stainless steel K-files: C files (Dentsply), C plus FILES(Dentsply, Schwed, Roydent), C pilot files (Dentsply), D finders (MANI), Sendoline K FINDERS, Sendoline S FINDERS, Hi-5 flies (Miltex), Pathfinder CS (sybronendo), Senseus (dentsply)	PathFiles (Dentsply/Maillefer)	WaveOne Gold Glider (Dentsply Sirona)
Hand files in reciprocating handpiece: M4 Safety reciprocating handpiece (SybronEndo, Coppel, Texas) The Endo-Express® System with the SafeSiders®	X-PLORER™ Canal Navigation NiTi Files (Clinician'sChoice Dental Products Inc., New Milford, USA)	R-pilot (VDW, Munich, Germany)
	G-Files (Micro-Mega, Besancon, France)	
	ProGlider (Dentsply/Maillefer)	
	EndoWave Mechanical Glide Path (MGP) (J Morita, California, USA)	
	Scout-RaCe files (FKG Dentaire, La Chaux-de-Fonds, Switzerland)	
	RaCe ISO 10 (FKG Dentaire)	
	Mtwo NiTi rotary instruments (Sweden and Martina, Padua, Italy)	
	Hyflex GPF (Coltene)	
	The Prodesign Logic 25.01 (Easy Equipamentos Odontológicos)	
	Pre-SAF instruments	
	ESX Scout (Brasselier, USA)	

Table 2: Advantages, disadvantage of manual glide path preparation with stainless steel K-files

Advantages	Disadvantages
Excellent tactile sensation.[19]	Increased operator fatigue.[21]
Small K-files on removing from the canal guides the clinician by giving the impression of the respective canal.[19,20]	Increased hand fatigue.[22]
Low potential for file separation.[19]	Increased time for the preparation of glide path.[22]
The stiffness of hand stainless steel files aids in negotiating blockages and calcifications.[19]	Increased risk of canal aberrations with larger K-file.[22]
Cost effective when compared to other glide path files.	Original anatomy of the canal is altered.[22,23]
No specific handpieces required.[21]	Piston action of K-files with push and pull motion results in increased apical debris extrusion.[24]

path preparation.[19-25] This technique involves the use of smaller sized k-files embedded in a reciprocating handpiece for glide path management.[21]

M4 safety reciprocating handpiece (SybronEndo, Coppel, and Texas)

The reciprocating handpiece M4 Safety (SybronEndo, Coppel, and Texas) is contra-angled and fits any slow-speed handpiece connection type E. The handpiece's reciprocating angle is 30° which effectively replicates the watch winding, oscillating hand instrumentation movement.[21]

The Endo-express® system with the SafeSiders®

It eliminates the fear of fracture associated with crown-down systems and the typical shortcomings of the step-back process. SafeSiders® are the only instruments with a patented un-interrupted flat along the entire working length. This flat:

- Reduces instrument engagement with less resistance allowing for faster advancement.
- Creates space for dentinal debris that would otherwise clog thread lines of conventional reamers and files.
- Reduces compressive and tensile stresses during use enabling improved instrument durability.
- Increased flexibility without sacrificing strength.
- It eliminates separation anxiety [Table 3].

Rotary glide path preparation techniques

Pathfiles (Dentsply/Maillefer) - 2009

The system consists of three instruments in ISO sizes (13, 16, and 19) and color (purple, white, and yellow), respectively. Each instrument is available in 21 mm, 25 mm, and 31 mm lengths. They have a square cross-section with a constant 2% taper. The gradual increase in tip diameter and low taper, markedly improves their flexibility and resistance to binding stress. The

Table 3: Advantages, disadvantage of using hand files in reciprocating handpiece for glide path management

Advantages	Disadvantages
Time required for glide path preparation shortened.[21]	Requires special handpiece.[21]
Reduced operator fatigue.[21]	Increased chance of apical transformation with larger files.[20,25]
Lesser chance of instrument separation over rotary NiTi methods.[25]	Excess removal of dentine because of longer working time.
Helps in negotiating difficult canal curvatures faster and with less hand fatigue.	Increased chance of apical debris extrusion, if handpiece inserted apically with force.[25]
	Reduced tactile sensation.[21]

four cutting edges increase their cutting efficacy, especially in calcified canals. They have a rounded, non-cutting tip with a tip angle of 50° which reduces the risk of ledge formation.

Recommended speed – 300 rpm and at a very high torque, approximately 5–6 N/cm (maximum torque available with the X-Smart, Dentsply Maillefer).

X-PLORER™ canal navigation NiTi files (Clinician's choice, New Milford, USA) – 2010

They consist of four instruments – #15 file with a 0.01 taper (triangular cross-section), #20 file 0.01 taper (square cross-section), #20 file 0.02 taper (square cross-section), and an optional #25 file 0.02 taper (square cross-section). Each instrument is available in lengths of 21 mm and 25 mm. 15 file sizes are available in both hand and rotary. They have a non-cutting tip with a tip angle of 75°. The varying cross-sections and lesser taper help the file in negotiating tortuous anatomy. The narrow taper improves flexibility and makes the files easier to advance through the canal. By constricting the cutting area to 10 mm from the apex of file, reduces the area of contact, improving the torsional resistance of the file.

Recommended speed – 400 rpm, Torque – 2 N/cm.

G-Files (Micro-Mega, Besancon, France) - 2011

The system consists of two files – ISO 12 and ISO 17 size, each in 21 mm, 25 mm, and 29 mm lengths. They have a constant 3% taper with an asymmetric non cutting tip that guides in the progression of instrument. It is recommended to use the file in delicate in and out motion till it reaches the working length. The G-Files™ superior cross-section blends efficiency and safety. They have cutting edges on three separate radii (snake-like motion), creating a large and productive area for removing debris upward. The angular offset of the cutting edges creates a different pitch along the blade's length, preventing any screwing or engaging impact on the canal walls. The cutting length consists of three flutes with the same pitch but with three different apparent pitches (the apparent pitch being the distance between two consecutive cutting edges). The high degree of flexibility resulting from the small diameter also contributes to progressive safe movement. They are manufactured by micro-milling and electropolished to improve mechanical properties.

Rotation speed: 400 rpm and 1.2 N/cm torque.

One G ((Micro-Mega, Besancon, France)

A single file system meant for single use in continuous rotation for glide path management. It has an innovative asymmetrical cross-section with a constant 3% taper, a non-working tip with ISO 14 tip size. A variable pitch between each cutting edge limits the screwing effect. The three cutting edges are situated on three different radii relative to the canal axis giving more space for better debris elimination.

Recommended speed – 400 rpm and Torque – 1.2 N/cm.

Proglider (Dentsply Sirona) - 2014

A single file system manufactured from M-Wire technology designed for glide path enlargement. It is available in three different lengths: 21 mm, 25 mm, and 31 mm. It has a square cross-section, a progressive taper of 2–8%, ISO 16 tip size and, and a diameter of 0.66 mm at D0 and 0.82 mm at D16.

Rotation: 300 RPM with a torque of 4–5.2 N/cm.

Endowave mechanical glide path (J Morita, California, USA)

This system comprises a set of three instruments in ISO size (10, 15, and 20) and color (purple, white, and yellow), respectively. They have a triangular cross-section with a constant 2% taper.

Rotation: Speed 800 rpm, Torque 30 g/cm–0.3 N/cm.

Scout-race files (FKG Dentaire, Switzerland) – 2014

The system consists of three instruments – ISO tip size 10 (purple), ISO tip size 15 (white), and ISO tip size 20 (yellow) and are available in three lengths: 21 mm, 25 mm, and 31 mm. They have a quadrangular cross-section with a constant 2% taper and non-cutting tip. They have unique feature of having four alternate cutting edges and are manufactured by micro-milling and electropolishing. They are recommended to use after initial canal negotiation with an ISO size 6/8 K-file.

Optimal speed: 800 rpm (minimum 600 rpm). Torque: 1.5 N/cm.

Race ISO 10 (FKG Dentaire) - 2010

The kit comprises three instruments – size #10–12% (yellow disk), size #10–14% (black disk), and size #10–16% (blue disk). They have a quadrangular/square cross-section with the unique feature of having same apical size and progressively increasing taper for all the instruments. With the slender design and their exceptional flexibility, the instruments follow the canal's anatomy perfectly, even in the middle and apical third. They are used without pressure up to the working length. The progressively increasing taper of the instrument helps in better coronal pre-flaring. Narrow, obliterated, and abrupted curvatures are ideal indications of this file.

Optimal speed: 800 rpm (minimum 600 rpm), Torque: 1.5 N/cm.

Mtwo NiTi rotary instruments (Sweden and Martina, Padua, Italy)

The set consists of two instruments – size #10/04, size #15/05. These files are manufactured from conventional NiTi wire. It has an S-shaped cross-section, a non-working tip, a positive inclination angle, large constant helical angle, more spirals for increased instrument stability, two cutting edges, and different tapers that prevent fracture and the transportation of debris toward the apex.

Recommended speed – 250–350 rpm, Torque – 1.2–2 N/cm.

Plotino *et al.* (2006) concluded that the Mtwo rotary instruments might be used safely under clinical conditions in molars with severe curvatures.[26]

HyFlex GPF (coltene)

The HyFlex GPF Controlled Memory Files consists of three files – 01/15 HyFlex GPF – 10 mm flute, 02/15 HyFlex GPF with CM*-16 mm flute, and 2/20 HyFlex GPF with CM*-16 mm flute. They are available in 21 mm, 25 mm, and 31 mm lengths.

The instruments can regain their shape during autoclaving (or treatment in a glass bead heater for 10 s). Nonetheless, caution must be taken if, during use, the instruments start rewinding in the opposite direction, the files will not recover their shape and should be discarded. If a file has multiple spirals after autoclaving that appear lengthened or otherwise seem unfunctional, the file should be discarded.

Recommended speed – 300 rpm (revolutions per minute), torque setting up to 1.8 N/cm.

The prodesign LOGIC 25.01 (easy equipamentos odontológicos) – 2014

It is a glide path made of both conventional NiTi Wire and CM-Wire. The file is manufactured by micro-milling and undergoes post-manufacturing heat treatment. It has a square shaped cross-section with a 1% taper and tip size of 0.25 mm.

Recommended speed – 350 rpm.

Pre-SAF rotary instruments

They are designed to provide suitable glide path preparation for the Self-Adjusting Files. The Pre-SAF instruments include, Pre-SAF OS (orifice shaper, sized #40/.10), Pre-SAF 1 (for narrow canals, sized #15/.02), and Pre-SAF 2 (allows glide path for the SAF 1.5mm, sized #20/.04). They have alternate cutting edges which help in reducing the screwing effect. Their tip is rounded to ensure the centralization of the instrument in the canal, for safety reasons. They are highly flexible, making it suitable for curved canals.

Recommended speed – 500–600 rpm, Torque – 1–1.5 N/cm.

ESX scout (Brasseler USA)

These are rotary NiTi files, with a size 0.15 at the tip available in 0.02 and 0.04 tapers. They have reduced cutting length (12 mm), tighter flute structure, triangular cross-section, and precision safety tip which facilitate negotiation of curved and calcified canals.

Reciprocating glide path preparation techniques

Waveone gold glider (Dentsply Sirona) – 2017

It is a single use sterile instrument manufactured from NiTi-Wire that is subjected to post-manufacturing heat treatment. It is used in reciprocating motion with a designated motor, before shaping canals with WaveOne Gold instruments. It has a parallelogram shaped cross-section with a variable taper between 2% (DO) and 6% (D16) and an ISO 15 tip size. The file has a 15 mm active cutting flute with a semi-active tip.

R-PILOT (VDW, Munich, Germany)

A single use glide path instrument manufactured from M-Wire technology. It is used in reciprocating motion with a designated drive system that uses the original Reciproc (VDW) settings to prepare the root canal system before shaping with a rotary or a reciprocating instrument. It has a s-shaped cross-section with a constant taper of 4% and an ISO 12.5 tip-size.

Apical debris extrusion following glide path management

Creation of glide path results in apical extrusion of debris. Although the amount of debris would be very low while creating a glide path, the initial extruded debris may contain debris of higher toxicity as compared with debris extruded later by the shaping instruments. Post-operative pain may be caused by apical extrusion of debris to periradicular tissues. The differences in the instrument geometric designs and movement kinematics affect the apical debris extrusion by the file. The piston action of K-files used with a push and pull motion pumps the irrigating solution and the debris through the apex as less space is available to flush it out coronally.[27] From the studies conducted so far, it is indicated that a rotary glide path instrument may be preferred as it extrudes less debris apically.[28,29]

Conclusion

Schilder coined the axiom "what comes out is as important as what goes in," accenting the flow of a perfect preparation which represents the original canal anatomy, enabling proper irrigation and obturation. Determining the canal length is not an exact science; it is an art form.[1] The rationale of endodontics requires the entire length of the root canal system to be cleaned and shaped. Glide path is a prerequisite to this mechanical objective. As the name suggests, glide path illustrates the gliding movement of rotary instruments in the canals.[4] The endodontic glide path is the key to radicular rotary safety. When done properly, it increases the longevity of rotary instruments; resulting in a healthy rotary outcome and a fully regulated endodontic experience. A glide path helps the clinician with a better understanding of the intricate anatomy of the canal, thereby enhancing the efficacy of the rendered treatment by reducing the possibility of instrument separation and other procedural errors.

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